

THE AGE AND ECOLOGY OF FOSSIL MOLLUSCA FROM RED BLUFF, SANDRINGHAM, VICTORIA

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Plate 1, Figs. 1-5.

At Red Bluff, Sandringham, on the east coast of Port Phillip, there is a high cliff of Tertiary rocks. At the base of the cliff is ironstone up to 15 feet in vertical thickness, above which is up to 85 feet of tinted clayey sands (Gill 1959, p. 169). The resistant ironstone forms a platform that juts out into the bay, while the softer sediments above are grooved with the deep rillways of badlands erosion. The section at Red Bluff is the type section for the Sandringham Sands Formation, the ironstone at the base being the Black Rock Member, and the clayey sands above the Red Bluff Member.

FOSSILS FROM THE MIOCENE SEA

The sediments that were later turned into ironstone were often coarse and not particularly well sorted. They were sandy in character, and the marine shells in them were often washed together into pockets. The remains of a tree trunk were also found at Red Bluff in the ironstone. This probably was ferried down a local river, became water logged in the sea, and sank. All these features suggest a shallow water environment. The ecology was probably not very different from the present one in that area, except that an open bay was probably there without the bay bar that characterises Port Phillip now.

After the deposition of these marine sediments and their fossils, the sea retreated, and they were lateritized under a subtropical climate with alternating wet and dry seasons. The ironstone is thus part of a fossil soil, and this is why it transgresses beds of different ages. For example, Balcombian beds at Frankston have been turned to ironstone, ? Bairnsdalian beds at Royal Park, and Cheltenhamian beds at Beaumaris. The severe leaching of the sediments during the formation of this ironstone dissolved away all the molluscan shells leaving only casts and moulds. Many ironstones in Victoria and contiguous states have been examined, and it has been noted that (1) no ferruginization of lateritic type (sense of Buchanan, e.g., see Gill, 1953) has affected rocks younger than uppermost Miocene (Cheltenhamian), and (2) the areas of lateritized rocks and of the Lower Pliocene marine beds are mutually exclusive. The justly famous molluscan Lower Pliocene faunas of the Lakes Entrance and Hamilton districts would not have been so beautifully preserved if the rocks had been lateritized. From the foregoing and other evidence it is inferred that the lateritization took place in Lower Pliocene time.

RESTORATION OF MOLLUSCA FROM RED BLUFF

Space scientists from the United States were in Melbourne recently making casts of australites, and some of the very fine grained plastic used by them was employed to restore the molluscs from Red Bluff existing only as casts and moulds. Plate 1, figures 1-2, show some of these restored specimens. As the ironstone at Red Bluff is part of a type section it is very desirable to determine its age accurately if possible. Foraminifera have been used very successfully for determining the age of Lower and Middle Tertiary formations, but in the Upper Tertiary (later than Bairnsdalian) they have not so far been successfully used. However,

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mollusca have been shown by R. W. T. Wilkins (1962, 1963) to be useful for determining the age of Upper Tertiary formations in S.E. Australia. Molluscs are here used for determining the age of the ironstone at Red Bluff.

MOLLUSCS FOR CHRONOLOGY

There are many ways in which molluscs can be studied. Living species may be studied and their variations noted over their geographic range. In such a study the factor of time is neglected. Nevertheless, such studies are important because it is often not realized what a great variation there is in some species from place to place. For example, *Placamen placidum* from New South Wales is not the same as that from Tasmania. It is all too easy for us to accept the local variation as the standard for a species. The type of *Placamen placidum* came from Tasmania (although the exact site is not known), so the Tasmanian variant is *P. placidum* sensu stricto. The variations in other places may be geographical races or clinal variants. Some species gradually merge into others; they have their own modes of variation but the limits of the two species partly overlap.

Then again molluscs may be studied by following not only the geographical variations (changes in space) but also the changes through the fossil record (changes in time). To trace the evolution of a molluscan genus in this way not only elucidates its biology but also makes available a dating mechanism because the changes are a function of time. The writer was asked by an international organization to study the boundary between the Tertiary and the Ice Age (the Plio-Pleistocene boundary) in Australia, so evidence has been collected for some years of both the evolving forms of life over this time and the changing environments in which they lived. It has been found that studying the molluscs evolutionally, tracing the changes in both time and space, has thrown a good deal of light on the problem. Two of these molluscan studies will be mentioned because they help to provide the age of the ironstone at Red Bluff.

THE PLACAMEN STORY

On three different occasions the writer has been requested to work out whether the living *Placamen placidum* (formerly called *roboratum*) and the fossil *P. subroboratum* are one species or two. All the living and fossil populations of these *Placamen* that were available were studied, Mrs. E. M. Davies carrying out long series of careful measurements to make possible an objective statistical check of the differences. It was

PLATE 1

- Fig. 1: *Zenatiopsis* sp. nov. Cast in plastic of external mould from ironstone at Red Bluff, Victoria. Note typical growth lines. P 22612.
- Fig. 2: *Placamen* sp. nov. Cast of external mould from ironstone at Red Bluff. Note typical ribs and the rounded outline of this species. P 22610.
- Fig. 3-4: *Zenatiopsis* sp. nov. The steinkern of paired valves viewed to show the left valve and right valve respectively. The cast of the hinge structures has not been figured. P 22613.
- Fig. 5: *Zenatiopsis* sp. nov. A left valve (which is more diagnostic than a right valve) of the new species from Muddy Creek, west of Hamilton, Victoria. Note the similar width and direction of the internal rib between this and the Red Bluff specimen. P 21898.
- N.B.: Numbers are registered numbers in the palaeontological collection of the National Museum of Victoria. Figures 1-4 are natural size, while figure 5 is x 1.5 approx.

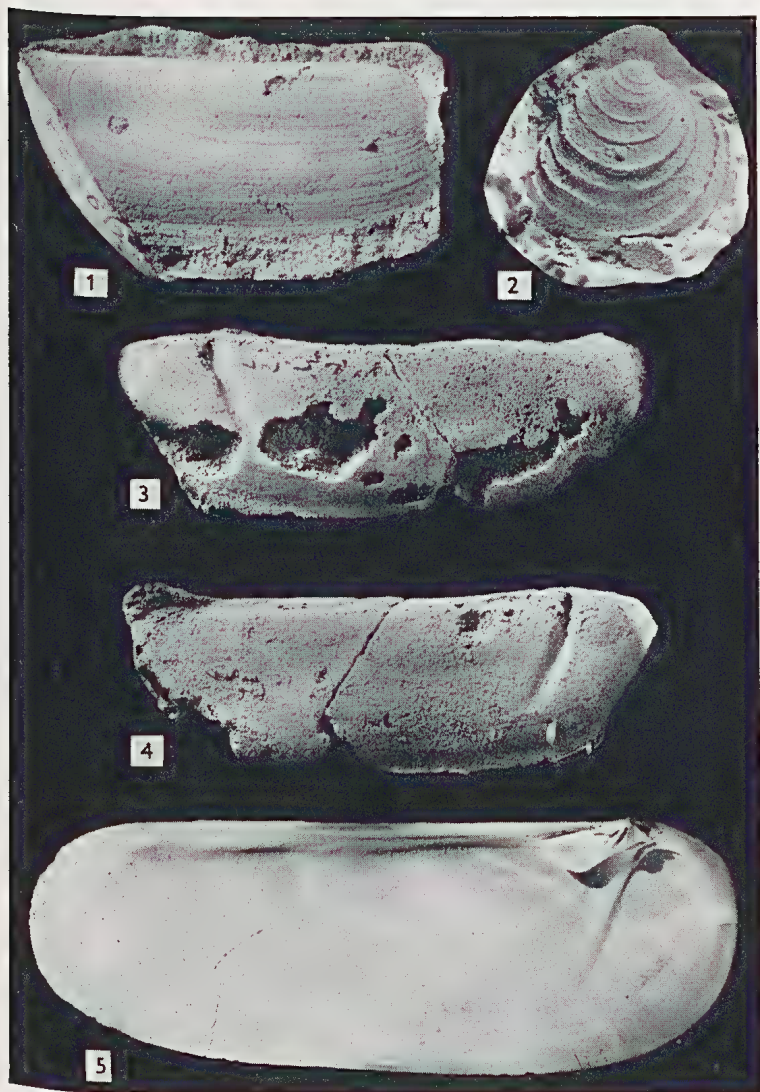


PLATE 1

discovered that the populations are very variable in both space and time, but that *P. subroboratum* is distinct from the living *placidum*, especially with respect to the flare in the posterior margin of the shell of the former species. These molluscs are also very variable in their growth stages. For example, the young of *P. subroboratum* are very like the adults of an earlier Miocene species (not yet described—Gill, 1962, p. 265) which does not have the flared posterior shell margin. The great variability is probably what has led people to doubt whether *placidum* and *subroboratum* are distinct species. One result of it is that a single specimen cannot always be determined, but if a random sample of an adult population (say six specimens) is viewed, there is never any doubt.

The new species of *Placamen* is limited to the Miocene (becoming extinct at the end of Cheltenhamian time), while *P. subroboratum* characterizes the Lower Pliocene (Kalinan). The living *P. placidum* is known from the late Pliocene (Maretimo Member) to the present. Thus the species of *Placamen* can be used for dividing the Miocene from the Pliocene. Although *Placamen* *sp. nov.* can be used to define the top of the Cheltenhamian stage (uppermost Miocene), it cannot be used to define the bottom because it extends back into the Mitchellian and perhaps earlier still.

THE ZENATIOPSIS STORY

The Zenatiinae are a subfamily of unusual mactrid molluscs that are not well known because they do not occur in the vast numbers in which *Placamen* appears, and because they are limited to particular facies in particular latitudes. The genus *Zenatiopsis* has a long evolutionary history, being known from the Oligocene to the Quaternary. The zenatiins are very conservative in shell structure, so that living ones do not look very different from ones that lived many millions of years ago. They changed little in either time or space. However, there are small but important and dependable features by which a succession of species may be recognized. The well known fossil *Zenatiopsis angustata*, described many years ago by Professor Tate, is the species that lived through much of the Miocene Period. At about the beginning of the Cheltenhamian Stage (uppermost Miocene), *Z. angustata* became extinct and a new species (described in Gill and Darragh, 1963) took its place. These two species become more alike as they approach one another in time, and so it is inferred that *angustata* evolved into the new species.

THE RED BLUFF PROBLEM

Some have expressed doubt as to whether it would ever be possible to solve the problem of the exact age of the Red Bluff ironstone because there are only a few molluscs there, and they exist only as casts and moulds that are often difficult to determine. Modern casting materials make it possible to restore the appearance of the original shell, while the evolutionary study of the molluscs (studying all available populations) makes it possible to fix the age of the deposit. The *Placamen* is of the new species limited to the Miocene, i.e. it is Cheltenhamian or older. On the other hand, the *Zenatiopsis* belongs to the species that is Cheltenhamian or younger. With the lower age limit set by *Zenatiopsis* *sp. nov.*, and the upper age limit set by *Placamen* *sp. nov.*, it is possible to solve the problem of the age of the ironstone at Red Bluff and to say that it is Cheltenhamian. It is of the same age as the beds in the cliff at Beaumaris above the nodule bed (Singleton 1941, Gill 1957). The evolutionary and ecological study of molluscs can solve many problems of taxonomy and stratigraphy, up to the standard of present knowledge. The Red Bluff

ironstone can be dated by only two molluscs because their evolutionary history and the range of variation among their populations is known in detail.

PLIOCENE LAGOONS AND DELTA

After the bed with the marine molluscs was laid down in shallow water at Red Bluff, the sea retreated, and a monsoonal type climate lateritized the sediments giving the ironstone we know today. Then the sea advanced again so that lagoons were formed along a sandy coast, for above the ironstone is a carbonaceous bed a foot or so thick that has yielded the pollen of three species of beech trees (*Nothofagus*), a species of eucalypt, the spores of tree ferns (*Cyathea*) and the skeletons of a species of marine hystrichosphaerids. The carbonaceous nature of the sediments, and the mixture of terrestrial and marine forms, suggest the deposit is a lagoonal one. Similar deposits are known in other places, including Hampton and Mentone. The 80 feet or so of clayey sands above the carbonaceous bed are interpreted as an ancient river delta. The Great Dividing Range was being built, and the sediments eroded from the uplifted land spread out to form a great delta across the area on which Melbourne now stands. No molluscs have been found in these sediments. Fossil snails have been sought assiduously (but without result), for these molluscs can throw light on both time and climate.

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